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Satellite observations of eddies in the Baltic, Black and Caspian seas

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In the present paper mesoscale and sub-mesoscale eddies in the Baltic, Black and Caspian seas are studied by means of satellite radiometer and radar images. Using these data makes it possible to investigate the vortical structures of a wide spatial range, from the basin scale through mesoscale to a small scale with a few kilometers in size. Over 2000 Envisat ASAR and ERS-2 SAR images with two-year time coverage (2009-2010) and spatial resolution of 75 m obtained in different parts of the Baltic, Black and Caspian Seas were applied to study submesoscale (with a diameter less than ca. 20 km) eddies in the basins mentioned.
As a result of the analysis performed the role of different mechanisms (ones due to surfactant films, wave/current interactions and thermal fronts) in eddy visualization in SAR imagery was revealed.
In every basin studied the main eddy characteristics such as number of eddies, frequency of their occurrence in SAR imagery, sign of vorticity, typical length scale and lifetime as well as spatial distribution patterns were investigated. Spatio-temporal parameters of the vortices were subjected to statistical analysis. Interannual and seasonal variabilities of the eddy parameters were traced.
Hypotheses about the most important mechanisms of generation of the eddies observed were proposed. Among them there are barotropic, baroclinic and topographic instabilities, convection in the surface layer and heterogeneous wind forcing.
Satellite infrared and visible images were used for retrieving statistical information on the Black Sea mesoscale vortical structures. The dataset used included ∼5000 AVHRR NOAA Sea Surface Temperature (SST) images covering the entire Black Sea with time coverage since September, 2004 to December, 2010 and ∼1500 MODIS Aqua (SST, normalized water-leaving radiance at 551 nm, chlorophyll-a concentration) images obtained in 2006-2010. Spatial resolution of the images was 1 km.
Analysis performed revealed that numerous vortical structures could be detected in the imagery mentioned. These structures were very different in their spatio-temporal scales and mechanisms of generation. It was discovered that the eddy types which could be especially frequently observed were the Rim Current meanders and rings, quasi-permanent anticyclonic eddies, near-shore anticyclonic eddies, mushroom-like currents (eddy dipoles), eddies of the Anatolian coast, and eddy chains. For each type of non-stationary eddies (the last four groups of eddies just mentioned), their spatio-temporal characteristics were retrieved such as areas of the most frequent generation and typical length scale as well as their seasonality and interannual variability.
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